FACTOR ANALYSIS - Hair.csv

Sanju Hyacinth C

3 June 2019

setwd("C:/Users/Sandy's XPS/Downloads/R downloads")  
getwd()

## [1] "C:/Users/Sandy's XPS/Downloads/R downloads"

Hairdata = read.csv("Factor-Hair-Revised.csv", header = TRUE)  
Hairdata

## ID ProdQual Ecom TechSup CompRes Advertising ProdLine SalesFImage  
## 1 1 8.5 3.9 2.5 5.9 4.8 4.9 6.0  
## 2 2 8.2 2.7 5.1 7.2 3.4 7.9 3.1  
## 3 3 9.2 3.4 5.6 5.6 5.4 7.4 5.8  
## 4 4 6.4 3.3 7.0 3.7 4.7 4.7 4.5  
## 5 5 9.0 3.4 5.2 4.6 2.2 6.0 4.5  
## 6 6 6.5 2.8 3.1 4.1 4.0 4.3 3.7  
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## 8 8 6.2 3.3 3.9 4.8 4.6 3.6 5.1  
## 9 9 5.8 3.6 5.1 6.7 3.7 5.9 5.8  
## 10 10 6.4 4.5 5.1 6.1 4.7 5.7 5.7  
## 11 11 8.7 3.2 4.6 4.8 2.7 6.8 4.6  
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## 13 13 9.5 5.6 4.6 6.9 5.0 6.9 6.6  
## 14 14 9.2 3.9 5.7 5.5 2.4 8.4 4.8  
## 15 15 6.3 4.5 4.7 6.9 4.5 6.8 5.9  
## 16 16 8.7 3.2 4.0 6.8 3.2 7.8 3.8  
## 17 17 5.7 4.0 6.7 6.0 3.3 5.5 5.1  
## 18 18 5.9 4.1 5.5 7.2 3.5 6.4 5.5  
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## 36 36 8.7 3.2 6.1 4.3 3.5 6.1 2.9  
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## ComPricing WartyClaim OrdBilling DelSpeed Satisfaction  
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## 63 5.8 5.0 4.4 2.9 6.3  
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## 66 8.2 5.4 4.7 5.2 7.6  
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## 68 6.0 5.6 4.5 4.3 6.1  
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## 72 5.0 5.2 2.9 3.1 5.8  
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## 82 6.8 6.3 4.3 4.0 7.4  
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## 84 8.4 7.3 2.0 1.6 5.0  
## 85 5.9 6.5 4.7 4.3 8.2  
## 86 7.6 4.9 3.4 3.4 5.2  
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## 90 6.3 7.4 5.5 4.9 8.2  
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## 98 5.6 5.0 3.1 2.5 5.4  
## 99 7.9 6.0 4.3 3.9 6.4  
## 100 9.7 5.7 3.4 3.5 6.4

Hairnew = Hairdata[,-1]  
Hairnew

## ProdQual Ecom TechSup CompRes Advertising ProdLine SalesFImage  
## 1 8.5 3.9 2.5 5.9 4.8 4.9 6.0  
## 2 8.2 2.7 5.1 7.2 3.4 7.9 3.1  
## 3 9.2 3.4 5.6 5.6 5.4 7.4 5.8  
## 4 6.4 3.3 7.0 3.7 4.7 4.7 4.5  
## 5 9.0 3.4 5.2 4.6 2.2 6.0 4.5  
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## 11 8.7 3.2 4.6 4.8 2.7 6.8 4.6  
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## 14 9.2 3.9 5.7 5.5 2.4 8.4 4.8  
## 15 6.3 4.5 4.7 6.9 4.5 6.8 5.9  
## 16 8.7 3.2 4.0 6.8 3.2 7.8 3.8  
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## 20 9.1 4.5 3.6 6.4 5.3 5.3 7.1  
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## ComPricing WartyClaim OrdBilling DelSpeed Satisfaction  
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## 33 9.2 5.7 3.5 3.4 5.4  
## 34 8.7 5.9 4.7 4.2 7.3  
## 35 8.4 6.2 2.5 3.5 6.3  
## 36 5.6 6.1 3.1 2.5 5.4  
## 37 6.8 6.4 3.9 3.5 7.1  
## 38 7.7 6.1 5.2 4.9 8.7  
## 39 9.0 5.2 4.7 4.5 7.6  
## 40 8.2 5.1 4.5 3.2 6.0  
## 41 9.1 4.1 4.6 3.9 7.0  
## 42 8.5 4.9 4.1 4.1 7.6  
## 43 7.4 5.1 4.6 4.3 8.9  
## 44 5.9 7.2 4.9 4.5 7.6  
## 45 5.2 5.1 4.3 4.7 5.5  
## 46 8.4 6.4 5.2 4.8 7.4  
## 47 3.8 6.7 5.0 3.5 7.1  
## 48 8.2 6.6 6.5 5.2 7.6  
## 49 6.8 5.9 4.5 3.9 8.7  
## 50 4.7 5.2 4.1 4.3 8.6  
## 51 7.2 5.7 4.0 2.8 5.4  
## 52 5.3 5.3 4.5 4.9 5.7  
## 53 6.3 6.3 4.7 4.6 8.7  
## 54 5.2 6.4 3.2 3.3 6.1  
## 55 8.7 5.3 4.9 4.2 7.3  
## 56 7.4 6.6 4.1 3.4 7.7  
## 57 9.6 6.4 5.7 5.5 9.0  
## 58 4.4 6.7 4.6 4.0 8.2  
## 59 3.8 6.7 3.7 3.5 7.1  
## 60 5.4 6.2 5.6 4.0 7.9  
## 61 4.9 7.2 5.4 4.5 6.6  
## 62 6.7 5.1 2.7 3.6 8.0  
## 63 5.8 5.0 4.4 2.9 6.3  
## 64 6.2 6.0 3.3 2.6 6.0  
## 65 7.2 6.5 3.5 2.8 5.4  
## 66 8.2 5.4 4.7 5.2 7.6  
## 67 6.2 7.5 5.0 4.5 6.4  
## 68 6.0 5.6 4.5 4.3 6.1  
## 69 7.6 5.1 4.0 3.4 5.2  
## 70 7.1 5.2 4.7 3.9 6.6  
## 71 8.4 7.1 5.4 4.4 7.6  
## 72 5.0 5.2 2.9 3.1 5.8  
## 73 8.7 4.7 4.6 4.6 7.9  
## 74 6.8 7.2 4.1 3.9 8.6  
## 75 6.8 5.7 4.4 3.7 8.2  
## 76 4.9 7.3 3.1 3.8 7.1  
## 77 7.4 8.1 4.5 3.9 6.4  
## 78 8.5 7.3 4.3 4.1 7.6  
## 79 4.6 6.6 5.2 4.6 8.9  
## 80 7.8 6.1 2.6 2.7 5.7  
## 81 4.9 5.9 3.2 3.8 7.1  
## 82 6.8 6.3 4.3 4.0 7.4  
## 83 6.3 6.1 2.7 3.0 6.6  
## 84 8.4 7.3 2.0 1.6 5.0  
## 85 5.9 6.5 4.7 4.3 8.2  
## 86 7.6 4.9 3.4 3.4 5.2  
## 87 8.2 4.3 2.4 3.1 5.2  
## 88 5.9 6.9 5.1 4.3 8.2  
## 89 8.3 6.5 4.6 3.9 7.3  
## 90 6.3 7.4 5.5 4.9 8.2  
## 91 7.3 7.5 4.4 3.3 7.4  
## 92 9.9 5.5 2.0 2.4 4.8  
## 93 7.1 6.2 4.4 4.2 7.6  
## 94 4.6 6.4 4.8 4.6 8.9  
## 95 7.4 5.3 3.6 3.4 7.7  
## 96 6.7 5.8 4.9 3.6 7.3  
## 97 7.2 4.5 4.2 3.7 6.3  
## 98 5.6 5.0 3.1 2.5 5.4  
## 99 7.9 6.0 4.3 3.9 6.4  
## 100 9.7 5.7 3.4 3.5 6.4

table(is.na(Hairnew))

##   
## FALSE   
## 1200

summary(Hairnew)

## ProdQual Ecom TechSup CompRes   
## Min. : 5.000 Min. :2.200 Min. :1.300 Min. :2.600   
## 1st Qu.: 6.575 1st Qu.:3.275 1st Qu.:4.250 1st Qu.:4.600   
## Median : 8.000 Median :3.600 Median :5.400 Median :5.450   
## Mean : 7.810 Mean :3.672 Mean :5.365 Mean :5.442   
## 3rd Qu.: 9.100 3rd Qu.:3.925 3rd Qu.:6.625 3rd Qu.:6.325   
## Max. :10.000 Max. :5.700 Max. :8.500 Max. :7.800   
## Advertising ProdLine SalesFImage ComPricing   
## Min. :1.900 Min. :2.300 Min. :2.900 Min. :3.700   
## 1st Qu.:3.175 1st Qu.:4.700 1st Qu.:4.500 1st Qu.:5.875   
## Median :4.000 Median :5.750 Median :4.900 Median :7.100   
## Mean :4.010 Mean :5.805 Mean :5.123 Mean :6.974   
## 3rd Qu.:4.800 3rd Qu.:6.800 3rd Qu.:5.800 3rd Qu.:8.400   
## Max. :6.500 Max. :8.400 Max. :8.200 Max. :9.900   
## WartyClaim OrdBilling DelSpeed Satisfaction   
## Min. :4.100 Min. :2.000 Min. :1.600 Min. :4.700   
## 1st Qu.:5.400 1st Qu.:3.700 1st Qu.:3.400 1st Qu.:6.000   
## Median :6.100 Median :4.400 Median :3.900 Median :7.050   
## Mean :6.043 Mean :4.278 Mean :3.886 Mean :6.918   
## 3rd Qu.:6.600 3rd Qu.:4.800 3rd Qu.:4.425 3rd Qu.:7.625   
## Max. :8.100 Max. :6.700 Max. :5.500 Max. :9.900

str(Hairnew)

## 'data.frame': 100 obs. of 12 variables:  
## $ ProdQual : num 8.5 8.2 9.2 6.4 9 6.5 6.9 6.2 5.8 6.4 ...  
## $ Ecom : num 3.9 2.7 3.4 3.3 3.4 2.8 3.7 3.3 3.6 4.5 ...  
## $ TechSup : num 2.5 5.1 5.6 7 5.2 3.1 5 3.9 5.1 5.1 ...  
## $ CompRes : num 5.9 7.2 5.6 3.7 4.6 4.1 2.6 4.8 6.7 6.1 ...  
## $ Advertising : num 4.8 3.4 5.4 4.7 2.2 4 2.1 4.6 3.7 4.7 ...  
## $ ProdLine : num 4.9 7.9 7.4 4.7 6 4.3 2.3 3.6 5.9 5.7 ...  
## $ SalesFImage : num 6 3.1 5.8 4.5 4.5 3.7 5.4 5.1 5.8 5.7 ...  
## $ ComPricing : num 6.8 5.3 4.5 8.8 6.8 8.5 8.9 6.9 9.3 8.4 ...  
## $ WartyClaim : num 4.7 5.5 6.2 7 6.1 5.1 4.8 5.4 5.9 5.4 ...  
## $ OrdBilling : num 5 3.9 5.4 4.3 4.5 3.6 2.1 4.3 4.4 4.1 ...  
## $ DelSpeed : num 3.7 4.9 4.5 3 3.5 3.3 2 3.7 4.6 4.4 ...  
## $ Satisfaction: num 8.2 5.7 8.9 4.8 7.1 4.7 5.7 6.3 7 5.5 ...

names(Hairnew)

## [1] "ProdQual" "Ecom" "TechSup" "CompRes"   
## [5] "Advertising" "ProdLine" "SalesFImage" "ComPricing"   
## [9] "WartyClaim" "OrdBilling" "DelSpeed" "Satisfaction"

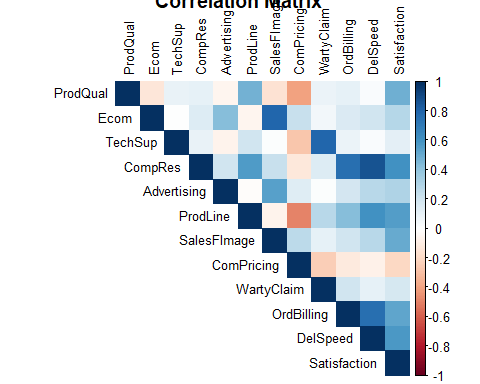
# CORRELATION   
  
library(corrplot)

## corrplot 0.84 loaded

Haircorr = cor(Hairnew)  
Haircorr

## ProdQual Ecom TechSup CompRes  
## ProdQual 1.00000000 -0.1371632174 0.0956004542 0.1063700  
## Ecom -0.13716322 1.0000000000 0.0008667887 0.1401793  
## TechSup 0.09560045 0.0008667887 1.0000000000 0.0966566  
## CompRes 0.10637000 0.1401792611 0.0966565978 1.0000000  
## Advertising -0.05347313 0.4298907110 -0.0628700668 0.1969168  
## ProdLine 0.47749341 -0.0526878383 0.1926254565 0.5614170  
## SalesFImage -0.15181287 0.7915437115 0.0169905395 0.2297518  
## ComPricing -0.40128188 0.2294624014 -0.2707866821 -0.1279543  
## WartyClaim 0.08831231 0.0518981915 0.7971679258 0.1404083  
## OrdBilling 0.10430307 0.1561473316 0.0801018246 0.7568686  
## DelSpeed 0.02771800 0.1916360683 0.0254406935 0.8650917  
## Satisfaction 0.48632500 0.2827450147 0.1125971788 0.6032626  
## Advertising ProdLine SalesFImage ComPricing WartyClaim  
## ProdQual -0.05347313 0.47749341 -0.15181287 -0.40128188 0.08831231  
## Ecom 0.42989071 -0.05268784 0.79154371 0.22946240 0.05189819  
## TechSup -0.06287007 0.19262546 0.01699054 -0.27078668 0.79716793  
## CompRes 0.19691685 0.56141695 0.22975176 -0.12795425 0.14040830  
## Advertising 1.00000000 -0.01155082 0.54220366 0.13421689 0.01079207  
## ProdLine -0.01155082 1.00000000 -0.06131553 -0.49494840 0.27307753  
## SalesFImage 0.54220366 -0.06131553 1.00000000 0.26459655 0.10745534  
## ComPricing 0.13421689 -0.49494840 0.26459655 1.00000000 -0.24498605  
## WartyClaim 0.01079207 0.27307753 0.10745534 -0.24498605 1.00000000  
## OrdBilling 0.18423559 0.42440825 0.19512741 -0.11456703 0.19706512  
## DelSpeed 0.27586308 0.60185021 0.27155126 -0.07287173 0.10939460  
## Satisfaction 0.30466947 0.55054594 0.50020531 -0.20829569 0.17754482  
## OrdBilling DelSpeed Satisfaction  
## ProdQual 0.10430307 0.02771800 0.4863250  
## Ecom 0.15614733 0.19163607 0.2827450  
## TechSup 0.08010182 0.02544069 0.1125972  
## CompRes 0.75686859 0.86509170 0.6032626  
## Advertising 0.18423559 0.27586308 0.3046695  
## ProdLine 0.42440825 0.60185021 0.5505459  
## SalesFImage 0.19512741 0.27155126 0.5002053  
## ComPricing -0.11456703 -0.07287173 -0.2082957  
## WartyClaim 0.19706512 0.10939460 0.1775448  
## OrdBilling 1.00000000 0.75100307 0.5217319  
## DelSpeed 0.75100307 1.00000000 0.5770423  
## Satisfaction 0.52173191 0.57704227 1.0000000

corrplot(Haircorr, method = "color",type = "upper", title = "Correlation Matrix", tl.cex = 0.8, tl.col = "black")



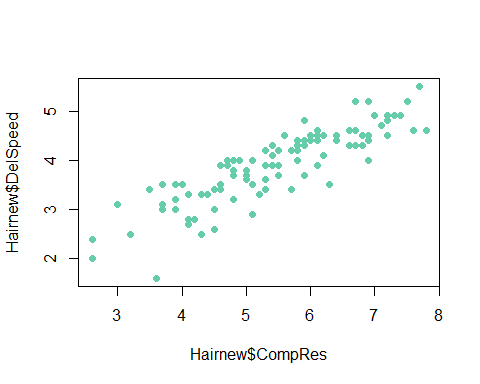
## QUESTION 1: MULTI - COLLINEARITY

The dependent variable being, customer satisfaction is moderately or highly correlated with almost all the other independent variables, like poduct quality, complait resolution, delivery speed, etc.

But we also find that there is a correlation between th independnt variables, for example, there exists a very high correlation between delivery speed and complain resolution, sales force image and E-Commerce, Warranty claim and technical support.

We can thus confirm that there is **evidence of multi collinearity in the data**

plot(Hairnew$CompRes, Hairnew$DelSpeed, col = "aquamarine3", pch = 16)



## FACTOR ANALYSIS

To find out if there is a possibility of variable reduction in the data, we use the *Bartlett Sphericity Test*

# Bartlett Sphericity Test for checking the possibility   
# of data dimension reduction  
  
library(psych)  
  
cortest.bartlett(Haircorr,nrow(Hairnew))

## $chisq  
## [1] 769.6422  
##   
## $p.value  
## [1] 1.65971e-120  
##   
## $df  
## [1] 66

# H0 : Data dimension reduction is not possible  
# Ha : Dimension reduction is possible

Since the p value is very much **lesser than 0.05**, we can conclude that the data dimensions can still be reduced to minimum factors

### METHOD1: KAIZER RULE OF EIGEN VALUES

In Kaizer rule, we take the number of factors basis the eigen values that are **greater than or equal to 1**. In doing so, we find that the overall variables can be reduced to just 4 factors

EV = eigen(Haircorr)  
EV

## eigen() decomposition  
## $values  
## [1] 4.04285997 2.55292440 1.69222417 1.21754639 0.63596293 0.56853132  
## [7] 0.40282774 0.32448016 0.23613948 0.14422355 0.09913845 0.08314143  
##   
## $vectors  
## [,1] [,2] [,3] [,4] [,5]  
## [1,] -0.1585512 0.313131524 -0.07356137 0.6140708 -0.24964531  
## [2,] -0.1661857 -0.440592609 0.23651951 0.1962824 -0.18886909  
## [3,] -0.1251433 0.238289845 0.61631236 -0.1794140 -0.03977108  
## [4,] -0.4226334 -0.001341205 -0.19665426 -0.2797050 -0.03340857  
## [5,] -0.1807615 -0.357245305 0.08986750 0.2060001 0.76107633  
## [6,] -0.3528387 0.297786674 -0.11122737 0.1000883 0.02506070  
## [7,] -0.2179500 -0.464888785 0.24094190 0.1994883 -0.14209236  
## [8,] 0.1348370 -0.417763172 -0.05166670 -0.2407948 -0.48964840  
## [9,] -0.1749912 0.201184203 0.60545958 -0.1895993 -0.02158615  
## [10,] -0.3879794 -0.009061557 -0.15503653 -0.3066857 -0.04908379  
## [11,] -0.4223407 -0.054457370 -0.21799023 -0.2899030 0.06222027  
## [12,] -0.4130246 -0.023903786 -0.02873859 0.3311899 -0.22967423  
## [,6] [,7] [,8] [,9] [,10]  
## [1,] 0.36499541 0.126407737 -0.326877510 0.18602426 -0.20370330  
## [2,] -0.46540483 0.008247843 -0.507851971 0.21574952 -0.03718659  
## [3,] 0.12392836 -0.013460766 0.081828178 0.54753081 0.42475155  
## [4,] 0.01495235 -0.004638175 0.149299321 0.43697539 -0.58601845  
## [5,] 0.41890840 -0.071550579 -0.122828960 0.04176506 0.02836138  
## [6,] -0.19582280 -0.633979131 -0.223191343 -0.23246141 0.25391841  
## [7,] -0.16711795 0.021650263 0.334109826 -0.17036570 -0.03993494  
## [8,] 0.58557549 -0.342805280 -0.163387635 -0.02851369 0.08642644  
## [9,] 0.14229590 -0.040119206 -0.107015819 -0.50449856 -0.45392345  
## [10,] 0.09117472 0.628742239 -0.334983752 -0.25197455 0.32105097  
## [11,] -0.03060577 -0.236927743 -0.001464018 0.07544805 0.05793177  
## [12,] 0.14296626 0.075206551 0.528541828 -0.13706617 0.21557147  
## [,11] [,12]  
## [1,] 0.22885317 -0.21787575  
## [2,] -0.02881148 0.35323725  
## [3,] -0.01766533 -0.10580091  
## [4,] -0.37853377 -0.05627641  
## [5,] -0.09687680 0.04824083  
## [6,] -0.34728677 -0.18600871  
## [7,] 0.07388433 -0.66500583  
## [8,] -0.10660117 0.01139137  
## [9,] 0.08277850 0.15868264  
## [10,] -0.15754746 -0.14716762  
## [11,] 0.78321219 0.06069937  
## [12,] -0.10623326 0.53252314

# Extracting the eigen values separately  
  
EValues = EV$values  
EValues

## [1] 4.04285997 2.55292440 1.69222417 1.21754639 0.63596293 0.56853132  
## [7] 0.40282774 0.32448016 0.23613948 0.14422355 0.09913845 0.08314143

print(EValues, digits = 4)

## [1] 4.04286 2.55292 1.69222 1.21755 0.63596 0.56853 0.40283 0.32448  
## [9] 0.23614 0.14422 0.09914 0.08314

# this is one method

### METHOD2: SCREE PLOT ANALYSIS

Another method that is used to determine the number of factors is a *Sree plot*. A scree plot displays the proportion of the total variation in a dataset that is explained by each of the components in a principle component analysis. It helps you to **identify how many of the components are needed to summarise the data.** A scree plot

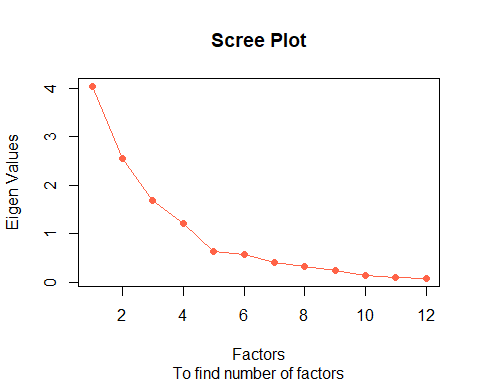
EValues

## [1] 4.04285997 2.55292440 1.69222417 1.21754639 0.63596293 0.56853132  
## [7] 0.40282774 0.32448016 0.23613948 0.14422355 0.09913845 0.08314143

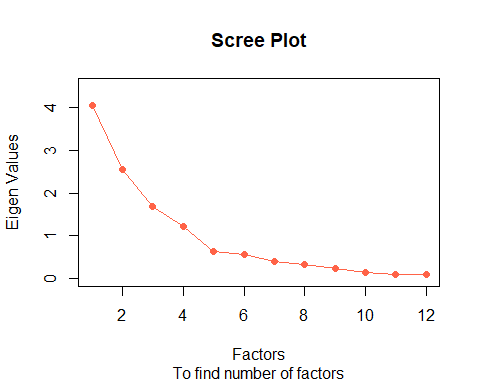
Factor = c(1,2,3,4,5,6,7,8,9,10,11,12)  
Factor

## [1] 1 2 3 4 5 6 7 8 9 10 11 12

Scree = data.frame(Factor,EValues)  
  
plot(Scree, main = "Scree Plot", sub = "To find number of factors", xlab = "Factors", ylab = "Eigen Values", col = "tomato", type = "o", pch = 16)



plot.default(Scree, main = "Scree Plot", sub = "To find number of factors", xlab = "Factors", ylab = "Eigen Values", col = "tomato", type = "o", pch = 16, xlim = c(1,12), ylim = c(0,4.5))



According to the scree plot, the number of factors in the plot uptil which, the eigen value drastically decreases to form an **elbow**, can be taken. In the above scree plot, we find that after factor 5, an elbow is formed as the below values are smaller and negligable. Hence, according to scree plot upo 5 factors an be taken under consideration

But since the 5th factor explains very little on the variance, we consider the eigen values equal to or more than 1 as per *Kaizer’s method*.

**Hence the ideal number of factors is reduced to 4**

## Principle Componenet Analysis

PCAHair = principal(Hairnew, nfactors = 4, rotate = "none")  
PCAHair

## Principal Components Analysis  
## Call: principal(r = Hairnew, nfactors = 4, rotate = "none")  
## Standardized loadings (pattern matrix) based upon correlation matrix  
## PC1 PC2 PC3 PC4 h2 u2 com  
## ProdQual 0.32 -0.50 -0.10 0.68 0.82 0.180 2.4  
## Ecom 0.33 0.70 0.31 0.22 0.75 0.251 2.1  
## TechSup 0.25 -0.38 0.80 -0.20 0.89 0.110 1.8  
## CompRes 0.85 0.00 -0.26 -0.31 0.88 0.117 1.5  
## Advertising 0.36 0.57 0.12 0.23 0.52 0.477 2.2  
## ProdLine 0.71 -0.48 -0.14 0.11 0.76 0.237 1.9  
## SalesFImage 0.44 0.74 0.31 0.22 0.89 0.110 2.2  
## ComPricing -0.27 0.67 -0.07 -0.27 0.59 0.406 1.7  
## WartyClaim 0.35 -0.32 0.79 -0.21 0.89 0.109 1.9  
## OrdBilling 0.78 0.01 -0.20 -0.34 0.76 0.236 1.5  
## DelSpeed 0.85 0.09 -0.28 -0.32 0.91 0.089 1.5  
## Satisfaction 0.83 0.04 -0.04 0.37 0.83 0.174 1.4  
##   
## PC1 PC2 PC3 PC4  
## SS loadings 4.04 2.55 1.69 1.22  
## Proportion Var 0.34 0.21 0.14 0.10  
## Cumulative Var 0.34 0.55 0.69 0.79  
## Proportion Explained 0.43 0.27 0.18 0.13  
## Cumulative Proportion 0.43 0.69 0.87 1.00  
##   
## Mean item complexity = 1.8  
## Test of the hypothesis that 4 components are sufficient.  
##   
## The root mean square of the residuals (RMSR) is 0.06   
## with the empirical chi square 40.15 with prob < 0.021   
##   
## Fit based upon off diagonal values = 0.98

PCAHair2 = principal(Hairnew, nfactors = 4, rotate = "varimax")  
PCAHair2

## Principal Components Analysis  
## Call: principal(r = Hairnew, nfactors = 4, rotate = "varimax")  
## Standardized loadings (pattern matrix) based upon correlation matrix  
## RC1 RC2 RC4 RC3 h2 u2 com  
## ProdQual -0.01 -0.03 0.90 -0.03 0.82 0.180 1.0  
## Ecom 0.05 0.85 -0.12 0.05 0.75 0.251 1.1  
## TechSup 0.02 -0.02 0.10 0.94 0.89 0.110 1.0  
## CompRes 0.92 0.12 0.11 0.05 0.88 0.117 1.1  
## Advertising 0.14 0.71 -0.01 -0.07 0.52 0.477 1.1  
## ProdLine 0.59 -0.10 0.62 0.16 0.76 0.237 2.2  
## SalesFImage 0.13 0.93 -0.10 0.06 0.89 0.110 1.1  
## ComPricing -0.09 0.28 -0.66 -0.27 0.59 0.406 1.8  
## WartyClaim 0.11 0.06 0.09 0.93 0.89 0.109 1.1  
## OrdBilling 0.86 0.11 0.05 0.08 0.76 0.236 1.1  
## DelSpeed 0.94 0.17 0.05 0.00 0.91 0.089 1.1  
## Satisfaction 0.52 0.48 0.57 0.04 0.83 0.174 3.0  
##   
## RC1 RC2 RC4 RC3  
## SS loadings 3.15 2.47 2.01 1.87  
## Proportion Var 0.26 0.21 0.17 0.16  
## Cumulative Var 0.26 0.47 0.64 0.79  
## Proportion Explained 0.33 0.26 0.21 0.20  
## Cumulative Proportion 0.33 0.59 0.80 1.00  
##   
## Mean item complexity = 1.4  
## Test of the hypothesis that 4 components are sufficient.  
##   
## The root mean square of the residuals (RMSR) is 0.06   
## with the empirical chi square 40.15 with prob < 0.021   
##   
## Fit based upon off diagonal values = 0.98

# We can confirm that 4 factors can explain maximum variation

Rotation may not be needed for the data, as we can distinguish as to whih principle component can explain the variables well.

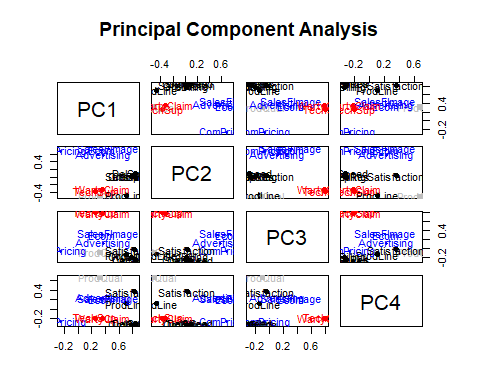
* PC1 explains **43%** of the variance
* PC2 with **27%** , PC3 with **18%** and PC4 with **13%**

And we find that the 4 factors can cummulatively explain the **total variance**

## FACTORS NAMING:

* PC1 includes Complaint resolution, Product line, Order and Billing, Delivery speed whichare major lookouts for purchasing. Hence, named **Purchase parameters**
* PC2 has E-Commerce,Advertising Sales force image and Competent pricing Hence grouped under **Market Focus**
* PC3 comprises of Technical support and Warranty claim, hence included under **Support**
* PC4 comprises of product quality and grouped to **Quality**

PCAHairplot = plot(PCAHair, row.names(PCAHair$loadings))



print(PCAHair$scores)

## PC1 PC2 PC3 PC4  
## [1,] 0.24266893 0.98405352 -1.48624653 1.23696632  
## [2,] 0.24526947 -1.54752676 -1.51860597 -0.93575837  
## [3,] 1.34990463 -0.47405185 -0.14351130 1.14151002  
## [4,] -1.10691135 0.10980793 1.42615897 -1.21318996  
## [5,] -0.31871315 -0.86685592 -0.20272494 0.33806363  
## [6,] -1.70491214 0.22947138 -1.16794761 -0.73069629  
## [7,] -2.56661334 0.76595474 0.42237941 0.77612198  
## [8,] -0.77570018 0.71510571 -0.54111772 -0.45449155  
## [9,] 0.26995709 0.83969506 -0.40601002 -1.55563488  
## [10,] -0.04342521 1.20350469 -0.21344811 -0.81159455  
## [11,] -0.17470027 -0.76311870 -0.65748740 0.51339128  
## [12,] -0.97476179 1.51866138 1.40668195 0.27735313  
## [13,] 1.51432903 1.12252743 0.25053849 1.18629937  
## [14,] 0.63199389 -0.96783440 0.03317279 0.25942063  
## [15,] 1.07627202 1.16410202 -0.47083391 -0.94864813  
## [16,] 0.46452768 -1.31422350 -1.21020099 -0.14996542  
## [17,] 0.14470075 -0.01870541 0.75882208 -1.51425810  
## [18,] 0.92538200 0.61577374 -0.34197478 -1.88100523  
## [19,] 0.15315262 0.80237140 -0.76304545 -1.73179550  
## [20,] 0.72375658 1.49386841 -0.38321008 0.99413499  
## [21,] -0.90790270 0.43227718 1.62696181 -1.58705240  
## [22,] 1.97496139 0.63942650 1.33994105 2.70444145  
## [23,] 0.54243617 -1.41102106 0.78323768 0.24779988  
## [24,] 1.14631120 -1.28642395 -2.03506176 -0.59915069  
## [25,] -0.51437939 0.53145324 0.48143473 -1.48079412  
## [26,] 0.06390240 0.38294837 0.35440782 -1.46311588  
## [27,] 0.63754287 -1.63974075 0.26945862 -0.78480058  
## [28,] -0.76766000 -0.17879322 0.03445104 -1.59597503  
## [29,] 0.43404936 -1.67915000 -1.00613481 -0.85470342  
## [30,] -0.98462617 0.79640355 -1.08665973 0.20004434  
## [31,] -0.25465712 -0.98321983 2.20735080 -0.39456641  
## [32,] -1.08690468 -1.51485445 0.89761092 -0.27126383  
## [33,] -0.74689748 0.73447105 0.49461510 -0.61674055  
## [34,] 0.11015558 0.44303795 -0.07081786 -0.41473450  
## [35,] -0.89550049 0.79262333 0.90614034 0.34953172  
## [36,] -1.23727429 -1.46113590 0.34064393 0.60554773  
## [37,] -0.24742531 -0.64752961 0.36550383 0.66197626  
## [38,] 1.47432793 -0.36013335 -0.43047020 0.04966890  
## [39,] 0.29879924 1.02217702 -1.17310871 0.06355981  
## [40,] -0.65927811 2.09642155 -0.27447398 0.25299753  
## [41,] -0.51741799 0.69838605 -1.90497963 0.13886798  
## [42,] 0.07816313 0.14254967 -1.05518090 0.89374781  
## [43,] 1.23386409 1.25332144 -0.55394881 1.69487130  
## [44,] 1.15876838 1.36566766 1.64491358 -0.99139340  
## [45,] 0.10917849 -1.48321865 -1.89226799 -1.00085040  
## [46,] 0.80823163 1.01793215 0.20127552 -1.14083449  
## [47,] 0.49049235 -1.20979029 0.80141690 0.62962709  
## [48,] 1.48260513 1.00129347 0.25452614 -2.22517224  
## [49,] 0.85170382 0.19353514 -0.61019510 1.69062943  
## [50,] 0.67710146 0.07096345 -0.77226300 1.21271658  
## [51,] -1.17040148 0.04214992 0.43694774 -0.35934107  
## [52,] 0.27069394 -1.51546017 -2.21047032 -1.08255578  
## [53,] 0.78050559 -1.23890898 -0.94982704 0.24724985  
## [54,] -0.68874908 -0.75175184 0.58053865 0.10525115  
## [55,] -0.17161665 0.30429271 -1.30265054 -0.50645835  
## [56,] 0.31503135 -0.41793931 0.97158068 0.66704530  
## [57,] 1.95972233 1.55726911 -0.27797368 -0.66175214  
## [58,] 0.79803760 -0.21772782 0.33569626 0.61693571  
## [59,] -0.20131901 -0.78620813 0.81596160 1.97062973  
## [60,] 0.62764356 -1.79860632 -0.37600118 -0.39644286  
## [61,] 0.83509422 -1.98508126 0.69834945 -1.09658265  
## [62,] -0.31531671 0.39095280 0.43327083 1.43786770  
## [63,] -0.62020595 0.13830151 -0.73002303 1.15289384  
## [64,] -1.45590544 -1.48767625 0.13662609 -0.31293779  
## [65,] -1.09678522 0.23752828 1.03288435 -0.13717773  
## [66,] 0.68397984 1.43612325 -1.13572279 -0.96630238  
## [67,] 0.46634255 -0.37240202 1.39505377 -2.23213037  
## [68,] -0.20950435 0.38212709 -0.42196987 -1.04860912  
## [69,] -1.43837779 0.18425473 -0.71152937 -0.06645506  
## [70,] -0.52435026 0.87534064 -1.15446500 -0.43956296  
## [71,] 1.14321304 1.25411841 1.13718862 0.45727245  
## [72,] -1.15905007 -0.14668446 -0.73412463 0.98186808  
## [73,] 0.66933833 1.89921400 -1.51119097 0.20531679  
## [74,] 0.91208873 -0.10335233 1.61840723 1.63453201  
## [75,] 0.28443778 0.59333981 0.08760231 1.02645874  
## [76,] 0.09665340 -1.07629298 1.19811664 1.24353847  
## [77,] -0.03333732 -0.19134240 2.02131313 -0.84556818  
## [78,] 0.67900154 -0.26988558 0.94891997 0.06775362  
## [79,] 1.80031045 -0.52384194 0.08917513 0.67927596  
## [80,] -1.28169417 0.41032692 0.68764215 0.54372155  
## [81,] -0.15328032 -1.19700749 0.51532842 1.25335653  
## [82,] 0.04891776 -1.07172178 0.08856276 -0.00294173  
## [83,] -1.12713228 -1.13167713 0.30672547 0.80103140  
## [84,] -2.33186879 -0.19594473 2.16142692 -0.40668693  
## [85,] 0.57978319 -1.58950027 -0.25285407 -0.98852860  
## [86,] -1.35024896 0.30181370 -0.74355020 0.01276143  
## [87,] -2.18392768 1.23191279 -1.39221584 0.17577527  
## [88,] 0.90324670 -1.45766698 0.41093998 -1.08609860  
## [89,] 0.20523228 -0.22116263 0.04554538 0.17263966  
## [90,] 1.81319598 1.73069353 2.10759291 -0.85126212  
## [91,] 0.11572939 -0.43693176 1.59661593 0.71757597  
## [92,] -2.52106079 0.70486378 0.35497235 0.36785526  
## [93,] 0.62220564 -0.42746813 -0.44304425 0.85116164  
## [94,] 1.62237205 -0.58628469 -0.33185629 0.74545894  
## [95,] -0.17262386 0.29790231 -0.52502829 1.83616506  
## [96,] 0.20984086 0.08608565 0.18088824 0.53559870  
## [97,] -0.80703619 0.60729940 -1.63157450 0.24330759  
## [98,] -1.69117461 -1.09944771 -1.03760444 1.29808081  
## [99,] 0.23925306 1.44398190 0.87418031 0.52322752  
## [100,] -0.80575238 0.81562422 -0.32409320 0.14468438

## REGRESSION MODEL:

attach(Hairdata)  
  
  
PCAHregres = lm(Satisfaction~ProdLine+DelSpeed+CompRes+OrdBilling+ProdQual+Ecom+TechSup+Advertising+SalesFImage+ComPricing+WartyClaim)  
summary(PCAHregres)

##   
## Call:  
## lm(formula = Satisfaction ~ ProdLine + DelSpeed + CompRes + OrdBilling +   
## ProdQual + Ecom + TechSup + Advertising + SalesFImage + ComPricing +   
## WartyClaim)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -1.43005 -0.31165 0.07621 0.37190 0.90120   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) -0.66961 0.81233 -0.824 0.41199   
## ProdLine 0.14034 0.08025 1.749 0.08384 .   
## DelSpeed 0.16570 0.19644 0.844 0.40124   
## CompRes 0.16703 0.10173 1.642 0.10416   
## OrdBilling 0.14635 0.10367 1.412 0.16160   
## ProdQual 0.37137 0.05177 7.173 2.18e-10 \*\*\*  
## Ecom -0.44056 0.13396 -3.289 0.00145 \*\*   
## TechSup 0.03299 0.06372 0.518 0.60591   
## Advertising -0.02602 0.06161 -0.422 0.67382   
## SalesFImage 0.80611 0.09775 8.247 1.45e-12 \*\*\*  
## ComPricing -0.03853 0.04677 -0.824 0.41235   
## WartyClaim -0.10298 0.12330 -0.835 0.40587   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 0.5623 on 88 degrees of freedom  
## Multiple R-squared: 0.8021, Adjusted R-squared: 0.7774   
## F-statistic: 32.43 on 11 and 88 DF, p-value: < 2.2e-16

The above model suggests that product quality, sales force image and Ecommerce are the most significant influencers of satisfaction